ART. XIII.—*Phenomena of Hailstorms in Victoria.* By R. BROUGH SMYTH, C.E., F.G.S., Hon. Sec. Phil. Inst. of Victoria, &c., &c.

HAILSTORMS are not uncommon in this country during the months of June and July. They also occur during the warmer months, and at periods when it is extremely difficult for the meteorologist to account for the congelation of waters at the altitude of the storm-clouds. The formation of hailstones, during the winter season, may be accounted for in part by the extremely low temperature of the air, as ascertained at the surface of the earth; yet the circumstances under which they congeal are unknown to us. It is frequently observed, for instance, that snow is falling on the ranges at the sources of the Dandenong, within thirty miles of the City, at an elevation of 1,500 feet, while showers of hail and rain are descending on the Plains, near the level of the sea.

The hail storms, during the winter season, appear to be quite distinct from those which occur during the summer, and properly may be considered separately. I shall place before you, very briefly, some of the phenomena of these meteors:—

On the 11th June, 1855, rain commenced to fall smartly at 6½ a.m., the barometer falling very slowly, the reading at 9½ a.m. being 29·945 in., and the thermometer indicating a temperature of 44° Fah., the air being completely saturated. The sky cleared a little at noon, the breeze having freshened from the south, and large dark grey cumuli were moving slowly northward—the barometer remaining steady. At 2 p.m. the temperature had risen to 47°, the dew point being 40°, when a smart shower of hail and rain fell. In this instance the barometer was remarkably steady, rising only 0·10 in. in six hours when corrected for diurnal range; and no sudden changes of wind occurred.

On the morning of the 12th, the lowest temperature recorded was 35°, and at 5½ a.m. heavy showers of hail and rain fell, continuing, at intervals, until 9½ a.m. A very faint breeze blew from the west, and the barometer, at 9½ a.m., had risen to 30.112 inches. In this instance, as in the former, no sudden changes of wind occurred. The clouds were dense and of a cold grey colour, alternately of the cumulus and nimbus form, the edges being of a silvery whiteness. They appeared to be of little elevation.

On the 17th June, 1856, showers of hail and rain fell at 1.30 p.m. The highest temperature recorded that day was 51.1°. It blew a brisk breeze from the west, and the barometer was moderately high and very steady. Dense nimbi formed in the S.W., and hail fell as the heavy clouds were borne overhead. The dew point during the day remained steadily at 41.8°.

On the 11th June, 1856, heavy showers of hail and rain fell at 9.30 a.m. The barometer had been as low as 29.659 inches the previous night, and had risen to 26.788 inches when the showers fell. The temperature of the dry bulb was 41.0°, and the dew at 37.6°. The highest temperature recorded during the day was 48.2°, and the temperature of the dew point altered very slightly. A brisk wind blew from the south, and no sudden change had occurred. Heavy showers of hail and rain again fell at 9.30 p.m., the clouds being of a dense grey colour.

The great similarity of the circumstance attending the hailstorms above described is somewhat remarkable, occurring as they do at similar seasons notwithstanding, for we might have expected them to have been connected with and modified by electricity; but in no instance was thunder heard or lightning seen. Electricity may, however, have been one of the causes of the decrement of caloric, and most probably on the 11th of July, when the atmospheric pressure was only equal to 29.659 inches mercury, considerable electrical disturbances did take place, though unobservable;* yet I am inclined to favour the opinion of Mons. Gay Lussac, who snpposes that the sudden cold is most often caused by radiation from the upper surfaces of the clouds.

Again, when we consider the indications of the barometer, we may suppose that the refrigeration is caused by the descent of cold currents of air; and during the winter season, with the thermometer at 54°, this is not very improbable. This theory is favoured by the circumstances, also, that these hailstorms are partial, generally very narrow in the track, and almost invariably accompanied by a squall of wind. Olmsted adopted this view, and subsequently abandoned it when he found it insufficient to account for hailstorms in India. This theory, and that of Gay Lussac, may serve to explain these meteors during our winter season, and to disconnect them altogether with the hail observed during the heat of summer.

It has been observed that hailstorms most often, but not

* See Views entertained by Humboldt. Cosmos—Vol. I., p. 189.

always, occur at the periods of the greatest heat of the day, and my observations during the past eighteen months confirm the general truth. Aware of this, Humboldt suggests that the dilation of the ascending current of air may account for the intense cold. This, again, would explain many of the winter storms, but could not apply to those of summer. Hailstorms during warm weather are, I believe, due to the meeting of opposing currents of air. This theory was originally proposed by Kamtz, and it has been corroborated by the observations of other meteorologists. In this country double currents of air are very often observed. Sometimes cirri may be seen at a great height moving slowly from the N.E., while scud and cold grey clouds are passing rapidly from the S.W., at an inconsiderable elevation. Now, we can easily comprehend how, under such circumstances, very considerable changes of temperature would take place, if by a decrease of atmospheric pressure, the north-east wind were to descend and mix with that from the south-west. Similarly, the converse of this would produce great changes, and as an illustration, I will describe the storm of the 23rd September, 1856. On the morning of the 23rd, the barometer had fallen to 29.793 inches, and dull grey clouds covered nearly the whole sky, the wind blowing briskly from the north. The temperature rose rapidly during the morning, and the sky cleared before noon. The thermometer continued to rise until about 2 p.m., the highest reading being 72 deg.; at half-past 3 p.m., it had fallen to 70.0 deg., the dew point being 56.5 deg., and the barometer had fallen to 29.682 deg. in. The wind, still from the north, was light. At this period of the day evidences of the coming change were observable in the sky. In the southern and western quarters dark cumuli were seen, which, at 4 o'clock, took the form of the cumulostratus clouds. They were large, and of a dark cold grey colour. At half-past four the wind suddenly changed to S.W.; small detached patches of dark scud of a remarkable appearance moved irregularly northward, joining the larger clouds at the base, and the barometer was observed to rise very slightly. Peals of thunder were heard as soon as the gust of wind came from the S.W., and violet-coloured forked lightning was seen three or four times. Rain and hail immediately followed the electric discharges, and the storm was of such violence, that cattle trembled and fled for shelter to the streets, exhibiting every sign of terror. Where the rain and hail fell most heavily, it was scarcely possible to see fifty yards

in advance. In about twenty minutes ·920 in. of rain was collected in the rain gauges. The path of this storm, from all accounts I can collect, appears to have been very narrow, and most violent in the northern parts of the city. The hail-stones were not large. On the following day the barometer rose rapidly, the weather was cold but fine during the morning, and after mid-day large *cumuli* and *nimbi* formed, and showers of hail and rain fell. At Geelong the storm was not felt.

It is not my intention to enter into any discussion of the many probable causes of the decrement of caloric suggested by such details as above described. Atmospheric electricity is not yet sufficiently understood to enable us to explain its influence satisfactorily in connection with the great and sudden changes of temperature which so often occur during thunder storms. It is evident, however, that the old theory of a cold current of air blowing against a rain cloud will not explain such phenomena. From whence could such a cold current come? And under what peculiar circumstances could it preserve its temperature? The collision of two currents of air of different electrical states, whatever the previous temperature of those strata may have been, is immediately followed by violent changes both of humidity and temperature; before the equilibrium is restored, successive flashes of lightning are seen, and during the period of the storm the thermometer by its indications shows the extreme rapidity of the changes; and that the thermometer, at the surface of the earth, only very faintly expresses the alternations of heat and cold in the higher regions where the storm clouds are, is proved by the state of the wet bulb, which not unfrequently is altogether irreconcilable with rain, when rain is actually falling.

I have hastily compiled these notes; but they will not be useless if they direct attention to the most remarkable phenomena of our climate.

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ART. XV.—*Report on the Steps taken in England to provide a Telescope for observing the Nebulæ of the Southern Hemisphere.* By PROFESSOR WILSON, M. A., Melbourne University.

THE Report which I have now the honour to lay before the Institute is little more than a narrative of the steps taken by the British Association for the Advancement of Science, in